

MODIS TECHNICAL TEAM MEETING

June 8, 1995

The MODIS Technical Team Meeting was chaired by Vince Salomonson. Present were David Herring, Paul Westmeyer, Steve Neeck, Harry Montgomery, Bruce Guenther, Ken Anderson, John Bauernschub, Locke Stuart, Dick Weber, Mike Roberto, Wayne Esaias, Al Fleig, Joann Harnden, Ed Masuoka, Barbara Putney, Chris Justice, Bill Stabnow, Ray Taylor, John Bolton, and Chris Scolese.

1.0 SCHEDULE OF EVENTS

June 13 - 14	MODIS EM Test Review at SBRC
July 17-18	MCST/SDST Peer Review at GSFC
Late Aug.-Sept.	Instrument Calibration Peer Review at SBRC
Oct. 17	MODIS Calibration Working Group at GSFC [tentative]
Oct. 18 -20	MODIS Science Team Meeting at GSFC [tentative]

2.0 MINUTES OF THE MEETING

Paul Westmeyer and Steve Neeck, both of the EOS AM Project, were invited by the MODIS Team Leader to present their ideas on the possibility of building a hyperspectral MODIS to fly in the EOS AM-2 timeframe.

2.1 EOS AM-2 General Topics

Westmeyer began the presentation with a brief self introduction. He said he was asked about 6 months ago to explore ways of making the EOS AM-2 platform physically smaller and potentially cheaper. Westmeyer said he began his exploration with the philosophy that all instrument performance requirements in place today must still be met on AM-2.

Westmeyer reported that he has some possible space-saving changes to make in the spacecraft guidance subsystems. He distributed a handout with notes of his presentation, as well as a block diagram of the instruments and star cameras (see Attachment 1). He emphasized three issues as "sacred," to be maintained on AM-2: 1) co-registration, 2) geolocation, and 3) calibration.

2.1.1 Co-registration

Westmeyer stated that because MODIS has four focal planes with multiple bands, he will have to go to great lengths in the design to ensure that the bands are co-registered. The future version of MODIS could be broken up into multiple cameras, so he would make sure its multiple views could be aligned once in space. Westmeyer said he would not co-register MODIS' bands on the ground; rather, they would be co-registered in orbit by actuators, similar to ones flown today (on HST).

Esaias observed that for the current version of MODIS, being built by SBRC, great emphasis was placed on achieving band-to-band precision and stability. He asked if the band centers on the AM-2 MODIS are sacred. Westmeyer responded negatively, but recognized that they are highly important.

The observation was made that if MODIS is made hyperspectral, then it may be difficult to maintain the specific band centers currently planned for observing specific physical phenomena. Moreover, the point was made that if some band centers are irregularly spaced in a hyperspectral MODIS it could throw off other important band centers.

2.1.2 Geolocation

Westmeyer stated that oceans and atmospheric measurements on EOS AM-2 will be better geolocated than AM-1 spacecraft measurements. Land measurements will be geolocated only as good as AM-1 due to errors introduced by terrain uncertainties. He said that the AM-2 platform will use a Global Positioning System (GPS) navigation system and will have new technology for bore sighting. Westmeyer expects AM-2 to offer attitude control to within 0.1 degree, with an attitude knowledge to within 1 arc sec. Integration times will be consistent with current star trackers--once per second.

2.1.3 Calibration

Westmeyer's plan for the AM-2 MODIS includes no instrument-specific onboard calibration subsystems. Instead, MODIS would rely on the transfer of radiometric data from another hyperspectral imager (HSI) aboard AM-2. Additionally, image data would be taken of deep space, the moon, and anything else desired. Westmeyer said that this configuration offers much more control authority at the subsystem level.

Vigorous discussion ensued pertaining to the viability of performing telescope-to-telescope registration on the ground, resampling, and the possibility of conducting some onboard processing for calibration. Montgomery feels strongly that a comprehensive error analysis must be done to show that one can use the moon in lieu of internal calibration sources, such as a blackbody. In short, he said, Westmeyer should be obligated to prove it can be done before the decision is made to follow his calibration strategy.

2.2 MODIS Follow On Hyperspectral Concept

Neeck began his presentation with a brief self introduction and stated that he too was asked a few months ago to explore instrument concepts for alternative options for the EOS AM-2 platform (see Attachment 2). Specifically, Neeck's focus is on exploring alternatives for MODIS-like and Enhanced Thematic Mapper (ETM)-like instruments to be incorporated into a much smaller spacecraft. His driving technical attribute for MODIS, aside from data and measurement continuity, was size and mass.

Neeck said his intent is to duplicate MODIS bands, increase spatial resolution for bands 8 - 36, add a blue band, and provide hyperspectral capability. By hyperspectral, Neeck means higher spectral resolution (e.g. bandwidths of 5 nm in the visible and near infrared) and more contiguous, continuous bands than are planned for the MODIS currently being built by SBRC. He noted that the swath width would be reduced to 1,235 km (to +/- 40 degrees from +/- 55 degrees). Salomonson indicated that his understanding was that a minimum swath width of +/- 45 degrees at 705 km is needed to obtain global 2-day coverage. Neeck indicated that this could be readily incorporated into the concept.

Neeck stated that a goal for the modified MODIS would be to have a constant resolution across the swath, as per the SPOT 4 Vegetation instrument. The instantaneous geometric fields-of-view at nadir will be decreased from 1,000 m to 500 m for bands 8 - 36. Bandwidths and centers will be chosen for spectral aggregation to form heritage bands for measurement continuity. Neeck explained that he used an integrated payload architecture in his design to eliminate duplication of functionality between the instrument and the spacecraft bus by shifting the data buffering, digital processing, and digital control functions to spacecraft subsystems.

In his design, Neeck minimized onboard calibration hardware. Instead, he said calibration would be accomplished by a Hyperspectral Transfer Radiometer (HTR), enhanced spacecraft maneuvering capability for lunar/space viewing, regular vicarious calibration using Earth scenes, and a diurnal (i.e. throughout selected orbits) stability monitor. Neeck stressed that there would be increased reliance on vicarious calibration methods for tracking the modified MODIS' performance.

Neeck's modified MODIS would have a pushbroom scanning mirror, instead of whiskbroom. A linear wedge filter would be used for spectral separation to eliminate the need for spectrometer optics, which would substantially reduce volume and increase mechanical robustness.

Neeck concluded that his study is presently incomplete and requires much additional work. However, results to date suggest that a smaller, MODIS-like (in data content) instrument suited to small spacecraft may be feasible.

2.3 General Discussion

Following the presentation, it was generally agreed that this is a useful exercise. Stuart asked the Team to review the presentation further, identify any issues which warrant further discussion or clarification, and then perhaps another presentation can be planned. Neeck pointed out that even if the MODIS Team doesn't propose a modified MODIS suited for small spacecraft, someone else may; so it will help to be acquainted with the system performance and design issues.

2.4 Level 1B Calibration Requirements

Montgomery submitted the following proposed MODIS Level 1B Calibration Requirements for distribution with these minutes:

For solar reflecting bands, the MODIS Level 1B software shall transform the MODIS solar reflecting bands sensor data to normalized radiances [$\rho \cos(\theta) d^2$]. This transformation is based upon the solar diffuser calibration and is not the quotient of the scene radiance and the model solar irradiance. Information shall be provided to transform from normalized radiances to scene radiance based upon the radiance-based calibration algorithm.

For the emissive bands, the MODIS Level 1B software shall transform the MODIS infrared bands sensor data to radiances in scientific units.

Please address comments to Harry Montgomery, at hmontgom@highwire.gsfc.nasa.gov, or call (301) 286-7087.

3.0 ACTION ITEMS

3.1 Action Items Carried Forward

1. *Discipline Group Leaders*: Identify contacts with appropriate IDS investigators, and encourage regular interaction.
2. *MCST*: Consider Yoram Kaufman's concerns and prepare an explanation or brief presentation for the Technical Team as to which unit is best suited for MODIS' Level 1 data--radiance or reflectance.
3. *MAST*: Begin preparing the Agenda for the next MODIS Science Team Meeting--begin planning topics for 2-hour to half a day roundtable discussions and team members to moderate them. Also, allow time for a 1- to 1.5-hour Discipline Group Splinter Session on the first day.
4. *Dave Diner & Ed Masuoka*: MODIS and MISR need to settle on a protocol(s) to deal with Level 1 and Level 2 data sets to be passed between the two teams to produce joint products. Report at the next SWAMP Meeting.
5. *Guenther*: Report the modeled results of the 1,000K source for SBRC's integration and alignment collimator to the Technical Team. [These data are forthcoming.]
6. *Fleig and Ungar*: Interact with the group leaders to develop a MODIS data simulation plan for review at the next Science Team Meeting. [Work on this item is still in progress. Simulated data are now available via FTP, and a white paper is forthcoming from Fleig.]

4.0 ATTACHMENTS

NOTE: All attachments referenced below are maintained in MODARCH and are available for distribution upon request. Please contact David Herring,

MAST Technical Manager, at (301) 286-9515, Code 920, NASA/Goddard Space Flight Center, Greenbelt, MD 20771 if you desire copies of any attachments.

1. AM-2 General Topics, by Paul Westmeyer
2. MODIS Follow On Hyperspectral Concept for EOS AM-2, by Steve Neeck